NEWBORNS IN TRAINING:

THE AMAZING JOURNEY FROM **FERTILIZATION TO BIRTH**

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Babies have charmed, fascinated, and baffled adults for millennia. Their impressive capabilities have yet to be fully discovered or appreciated. We love to watch their "firsts"– the first breath, first cry, first smile, first roll, first steps. Since these mysterious little ones achieve so many milestones long before birth, key insights into their world can be gained by looking at their development from the very beginning.

THE FIRST 8 WEEKS AND BEYOND

Human development begins at fertilization and unfolds with startling speed, as the single-cell embryo becomes a 1¼-inch long, one billion-cell embryo with more than 4,000 permanent body parts during the 8-week embryonic period. During this time, all body systems and most body parts appear and begin to function. The 8-week brain, spinal cord, heart, and limbs are remarkably complex and, like the embryo itself, closely resemble their newborn counterparts.

7½-week embryo

The fetal period (8 weeks to birth) is marked by the rapid emergence of increasingly complex abilities and an enormous increase in size.

TRAINING FOR INFANCY BEGINS LONG BEFORE BIRTH

Newborns are not only charming, they are surprisingly capable. For example, they can move in all kinds of ways, breathe air, breastfeed, and much more. Newborns may look "new" but they have practiced essential "life skills" for many months before birth, usually beginning just as soon as the necessary body parts appear.

Movement, both spontaneous and reflexive, begins by 5½ to 6 weeks, coinciding with the first appearance of muscles. Lightly touching the mouth region causes the embryo to withdraw its face. First movements include turning the head side to side and subtly twisting the trunk. Hand and leg motions begin by 7 weeks, at which time a "startle" response may be seen. By 7½ weeks the hands and feet can touch in the midline and hand-to-mouth motions begin. The first sign of hand preference (right- or left-handedness) appears at 8 weeks. By this time these little ones can roll over and even perform somersaults! Stretching begins at 9 weeks and complex facial expressions are seen by 11 weeks.

A full-term newborn has been moving for 32 weeks before birth!

Breathing has a similar history. The diaphragm (primary breathing muscle) is substantially formed by 6 weeks, and hiccups, caused by a twitching of the diaphragm, begin shortly thereafter. By 8 weeks the diaphragm is complete, and intermittent breathing motions begin — leaving a full 30 weeks to strengthen this muscle for continuous service after birth. Two familiar breathing variants, the sigh (a long, deep exhalation) and the yawn (a long, deep inhalation), begin at 9 and 9½ weeks, respectively.

A full-term newborn has been training to breathe for 30 weeks!

Breastfeeding involves latching on to mom's nipple, sucking to stimulate the release of breast milk, and swallowing. Here's why most newborns adapt to breastfeeding so easily:

- Lightly touching a newborn's cheek will cause the little one to turn toward the touch and try to latch on to something and suck. This "rooting reflex" is helpful for breastfeeding as a baby seeks out mom's nipple. "Rooting" is not new. It first appears just 9 weeks after fertilization.
- Sucking motions are also first seen at 9 weeks. In fact, thumb sucking was photographed at 9 weeks in utero by the famous A. W. Liley, known as the "Father of Fetal Therapy."
- Swallowing is a complex maneuver, which requires coordinated action by the nerves and muscles of the esophagus to deliver mouth contents to the stomach. Swallowing amniotic fluid also begins at 9 weeks.

A full-term newborn has been actively preparing to breastfeed for 29 weeks!

PRACTICE MAKES PERFECT

A newborn baby is like a world-class athlete or musical prodigy, whose success comes after practicing essential skills countless times until perfected. However, the level of teamwork between a pregnant mom and her developing baby far exceeds anything possible in sports or music.

In just 38 weeks, the single-cell embryo gives rise to the newborn's 200+ cell types and two trillion cells, which are superbly organized into thousands of body parts and a dozen exquisitely functioning body systems. It's enough to make any mom or dad proud!

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THE AMAZING JOURNEY FROM **FERTILIZATION TO BIRTH**

Age in weeks

0

Zygote forms • Early pregnancy factor • First cell division

Fertilization |
Human development and pregnancy begin • Embryo forms


Single-cell embryo

Embryo travels towards uterus • Activation of genome

Blastocyst • Inner cell mass • Future location of back and chest identifiable

Morula (12–16 cells)

Embryo reaches uterus •
Embryo "hatches" (escapes from its protective shell) •
Epiblast and hypoblast

Amniotic cavity begins forming • Implantation begins

Placenta formation begins

1

Positive pregnancy test (β-HCG)

Amnion • Primary yolk sac

Implantation ends (10–12 days)

First blood vessels • Future location of head, right and left sides evident • Bilateral symmetry

Size: < 1/100th in

2

3 germ layers: ectoderm, mesoderm, and endoderm

Primordial germ cells • Primitive streak | **First blood cells** (3 types)

Brain has 3 main sections: forebrain, midbrain, and hindbrain • Neural crest • Otic discs (will form inner ear) • Spinal cord and heart development begin • Pericardial cavity • First somites

Brain development begins | Neural plate • Digestive tract

Neural tube formation begins •
Eye development begins •
Tubular heart begins folding
| Heartbeat begins

3

Nose, upper and lower jaw development begins • Internal carotid arteries • Thyroid gland begins • Foregut, midgut, and hindgut • Reproductive cells: oogonia in girls, spermatogonia in boys

Upper limb buds • Descending aorta

> 1 million heartbeats ♥ Head to rump: ¼ in

4

4-Chambered heart
Head, chest, abdomen, and all limbs distinct • First cranial nerves • Pharyngeal arches • Stomach

Cerebellum • Cerebral hemispheres
Spinal nerves • Esophagus • Liver • Gallbladder • Trachea (windpipe) • Lung sacs (right and left) • Permanent kidneys

Hand plates

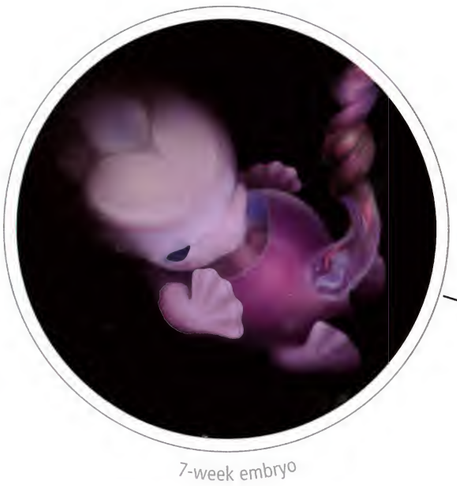

5-week embryo

Cerebral cortex • Dorsal thalamus • Neurons synapse in spinal cord • Pigmented retina • Primary nasal cavities • Rectum

5

Nerves enter hand plates • Nipples • Foot plates

Reflex movement


7-week embryo

Head to rump: ½ in

6

Turns away if touched near mouth
Synapses in brain • Startle response • Tongue • Cartilage

Brainwaves • Hiccups
Ossification (bone formation) begins in collar bone and jaw • Tooth formation begins • Larynx (voice box) • Bladder • 400+ new parts including dozens of new muscles this week

actual size

7

Turns neck • Moves hands • Biceps and quadriceps muscles • Heart rate peaks at 170 bpm • Ovaries in girls, testes in boys

Touches hands and feet in midline • Touches hands to mouth • Fingers completely separate • Electrocardiogram (EKG) resembles adult pattern • Knee caps • 1600+ new parts including hundreds of new muscles this week

Head to rump: 1¼ in

8

Right- or left-handed • Breathing motions
Nerve bundles in fingertips • Urination begins • Toes separate • Embryo now possesses more than one billion cells and 4000 permanent body parts

Moves jaw actively • Thumb sucking
Swallows, sighs, and stretches • Moves head forward and back • Responds to light touch on face, palms, and soles • Uterus in girls

9

> 10 million heartbeats ♥ Head to heel: 3 in • Weight: < 1 oz

10

Yawns • Moves eyes
Senses touch throughout limbs • Fingernail and toenail growth begins • Unique fingerprints begin

Complex facial expressions • Lips and nose fully formed •

11

EMBRYONIC PERIOD

EMBRYONIC PERIOD

Able to smile • Secondary palate • Produces thyroid hormones

Head to heel: 5 in • Weight: 2 oz — **12** — **Taste buds** | Cheeks complete • Bowel movements • Distinct male or female genitals

Responds to light touch nearly everywhere — **13**
Ear drums • Tooth dentine

Head to heel: 7 in • Weight: 4 oz — **14** — Fat deposits in cheeks

Blood formation begins in bone marrow • Fat around trunk • Several digestive enzymes produced — **15**


15-week fetus

> 20 million heartbeats ♥ Head to heel: 8 in • Weight: 6 oz — **16** — Hormonal stress response to invasive procedures • Enamel in teeth

Mom feels movement (quickening) 14–18 weeks — **17**

Head to heel: 10 in • Weight: 9 oz — **18** — Vernix caseosa covers skin (protects from drying)

Number of oogonia (early eggs in ovaries) peaks at about 7 million • Motion in voice box • Hair on scalp • Breathing, movement, and heart rate follow circadian rhythms — **19**

Head to heel: 11 in • Weight: < 1 lb — **20** — **Age of viability • Hearing begins**
If born prematurely, up to 40% survive • Eyes reopen • Organ of hearing (cochlea) reaches adult size • REM sleep

If born prematurely, up to 63% survive — **21**

Head to heel: 12 in • Weight: 1¼ lbs — **22** — Breathing motions seen 14% of the time

All skin layers, structures, and glands present — **23**


26-week fetus

Head to heel: 14 in • Weight: 2 lbs — **24** — Blink-startle response (earlier in girls)

25 — Rods and cones in retina

Head to heel: 15 in • Weight: 2½ lbs — **26** — **Sense of smell and taste** | Eyes produce tears

27 — **Pupils react to light** | Continued rapid brain growth

Head to heel: 15 in • Weight: 3¼ lbs — **28** — Distinguishes high- and low-pitched sounds

Sleep patterns become cyclical — **29**

Head to heel: 17 in • Weight: 4 lbs — **30** — Breathing motions seen 40% of the time

31

Head to heel: 18 in • Weight: 5 lbs — **32** — Alveoli • All neurons formed

Voice and music memories forming — **33**

Head to heel: 18½ in • Weight: 5¾ lbs — **34** — Amniotic fluid volume peaks

Firm hand grip — **35**

> 50 million heartbeats ♥ Head to heel: 19 in • Weight: 6¾ lbs — **36** — Nails reach fingertips

Drinks up to 25 ounces daily — **37**

Head to heel: 18–21 in • Weight: 6–9 lbs — **38** — **Labor • Baby is born!**
Transitions to air breathing • Now possesses two trillion cells


Newborn baby

Full-term pregnancy lasts 38 weeks when measured from fertilization to birth, or 40 weeks, if measured from the beginning of a woman's last menstrual period. All ages here refer to the time since fertilization. If you are pregnant, you can make a free Little One Pregnancy Calendar on Facebook to learn much more about your developing baby.

www.ehd.org

DID YOU KNOW?

Human development and pregnancy begin at fertilization (or conception). Fertilization begins within a woman's uterine (or Fallopian) tube when a man's sperm makes contact with a woman's oocyte, forming a single-cell embryo. It ends with the union of mom's and dad's chromosomes. Fertilization is a 24-hour process so there is no such thing as "the moment of fertilization."

The first pregnancy hormone, called Early Pregnancy Factor (or EPF), appears in a woman's bloodstream as early as 24 hours after fertilization.

Brain development begins 18 days after fertilization with the emergence of the neural plate. The cerebellum and cerebral hemispheres first appear at 4½ weeks. Brainwaves have been recorded by 6½ weeks. By 32 weeks the brain has its full complement of nearly 100 billion (10^{11}) neurons (nerve cells). Each neuron eventually connects (synapses) with up to 200,000 other neurons, creating an electrical network of incalculable complexity.

The heart begins to beat 22 days after fertilization. It beats more than one million times by 28 days and 53 million times before birth. By 7 weeks the heart is largely complete, and by 7½ weeks the heart's electrical pattern (called an EKG or ECG) is surprisingly similar to that of newborns and adults.

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